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Enhancing fluorine anion reactivity in organo-silane and organo-boron polymers through Titanium Dioxide blending

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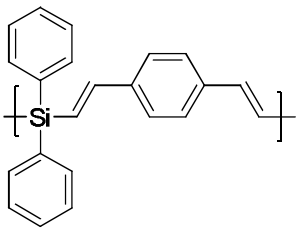
The detection of fluorine is prevalent for environmental, health, and safety concerns because of the anions ability to be stable in aqueous conditions that allow it time to bond with an exhausted list of cation species. In this unique work, organic silane and boron polymers were synthesized and investigated using a chemoresistor platform [1] (interdigitated electrodes) in prepared aqueous solutions for testing. The addition of titanium dioxide (TiO_2) nanoparticles (30-70nm), Sigma-Aldrich (99.5%), at 40 wt.%, to poly(1,3- diethenyl diphenylsilane)polymer blends [2,3] enhanced sensitivity and selectivity to 100ppm hydrofluoric acid, when directly compared to 100ppm hydrochloric acid, sulfuric acid, nitric acid, and deionized water. Figure 1, describes the synthesized silane and boron polymer structures. A programmatic requirement of 100 S/cm conductivity was required for testing, in which the addition of multi-walled carbon nanotubes (~5-20 wt.%) provided 2-5 ohm's starting resistance on a two-port measurement. Figure 2 (a) and (b), describe the blending of titanium dioxide nanoparticles into the polymer matrix for sensitivity and selectivity to the fluorine anion. The polymer's impedance response to the acidic conditions was measured using a 10 mV signal at 20Hz from an Agilent E4980A LCR meter. Impedance measurements in solution detected a permanent 30-33% change in 600 seconds, with a repeatable 20:1 selectivity. The sensitivity of the polymer composite was investigated further by exposing the sensing platform to lower concentration as low as ~1ppm (solution) a 6% change in resistance was observed for these low concentration exposures,



efined and optimized to a

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change in resistance in deionized water compare

The sensor performance and selectivity impro

Figure 4, describes the change in sensitivity a

100ppm fluorine and nitric acid, when compared

The response to deionized water is a 3% change

resistance, and hydrofluoric acid has a 46% chan

response is still being investigated, however, t

dioxide into these polymers for enhancing the s

acid.

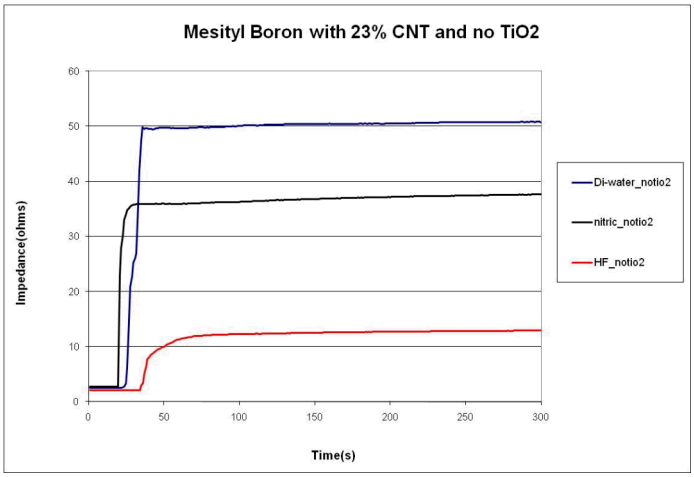
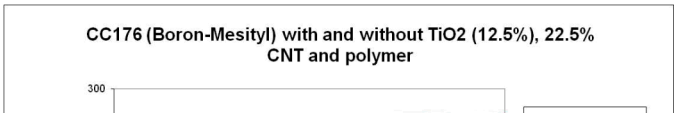
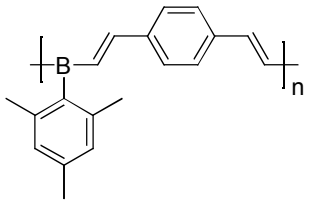


Figure 3. Describing the Mesityl Boron blend without TiO_2 and only 23 wt.% of MWCNT.

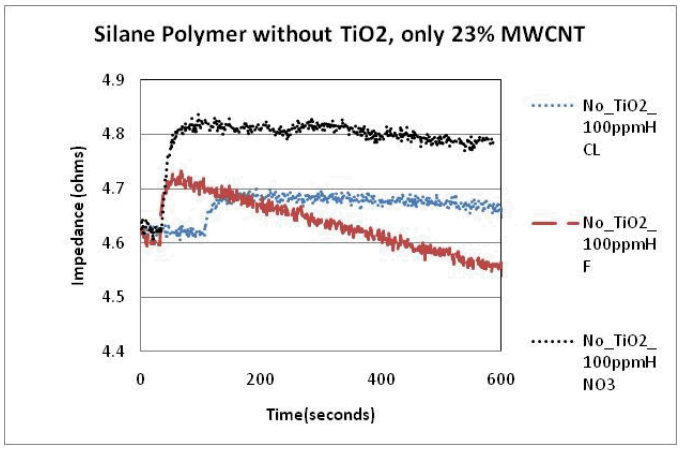


(a)



(b)

Figure 1. (a) describing the silicon containing polymer, (b) the boron based polymer.



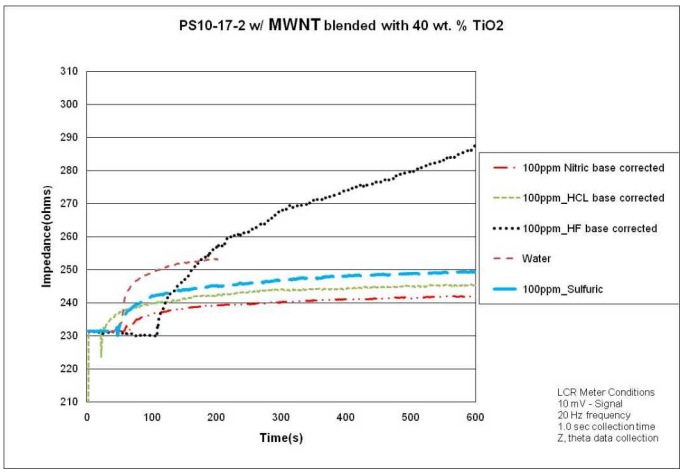


Figure 2. (a) describing the silane polymer blend Without TiO_2, and (b) the response with 40 wt.% TiO_2.